

"SPELTER CHILLS."

BY DAVID RIESMAN, M.D.,

AND

RUSSELL S. BOLES, M.D.,

PHILADELPHIA.

(From the Medical Division of the Philadelphia General Hospital.)

In recent years the results obtained from the study of occupational diseases has been most gratifying. Such a study not only often aids in arriving at an otherwise difficult diagnosis, but as a part of industrial hygiene it has become of great importance in the prevention of those ills that are the result of occupation.

With this in mind a systematic study of occupational diseases is being made in the medical division of the Philadelphia General Hospital, and the affection about to be described is one of a number of interesting conditions revealed by this study.

"Spelter chills" is the name given to a condition heretofore but briefly described under such varying terms as brass-founders' ague, brass chills, zinc chills, smelter shakes, *das Giesfieber* or *Staubfieber*, and *fièvre des fondeurs*. We believe the condition results from the inhalation and ingestion of the fumes and flakes of zinc oxide arising from the melting and volatilizing of spelter, which is the commercial name for zinc in its impure state. Spelter chills we found to be the name popularly employed among the local workmen.

The chills occur in brass foundries, in zinc smelters, and in places where zinc is poured. The majority of instances are found in places where yellow brass is manufactured, a process in which a large percentage of zinc is used. The chills do not occur in those engaged in processes in which the zinc is not volatilized. Lehman produced it artificially in a workman by burning zinc. Some investigators have suspected copper as the cause of the chills. This seems unlikely in view of the fact that in the manufacture of red brass, which contains a large percentage of copper and a small percentage of zinc, the chills occur less frequently than in the manufacture of yellow brass, which contains a greater percentage of zinc than of copper. In brass workers employed in finishing or polishing of brass, though they inhale quantities of copper-laden dust, as is shown by the excretion of copper in the perspiration imparting a greenish tinge to the skin, hair, and underclothes, the chills never occur. Lead as a contributory cause may be considered a negligible factor.

A brief description of the process which exposes the workers to

¹ Read before the Section on General Medicine of the College of Physicians of Philadelphia, March 27, 1916.

this nilment may be of interest: Zinc is obtained from its ores, zinc sulphide or zinc blende and zinc carbonate or calamine. Brass is ordinarily of two varieties, red and yellow. The red brass, the better quality, is made up of from two to four parts copper and one part zinc. The yellow brass is made up, roughly, of three parts copper and two parts zinc. The relative proportions of zinc and copper thus determine the quality of the brass.

Brass is manufactured by either the direct or the indirect process, the latter being the safer, though the former is probably in more common use. In the direct process the metals are all fused together at the same time. In the indirect they are fused one after another, the order depending upon the relative fusibility and volatility. The metals are melted in a large crucible, which is first heated to avoid breaking. Into the crucible is put, first, a mixture of scrap brass or grain copper; rarely are the pure copper and zinc directly mixed in their definite proportions. After the material is melted down the proper amount of copper or zinc is added to secure the desired composition. It requires 2000° F. to melt copper and 770° F. to melt zinc. Hence the necessity of adding the zinc last. Zinc is readily volatile above 770° F., and for this reason must be well submerged beneath the surface of the melted copper. The mixture is then poured into molds. Though the process up to this point exposes the workmen in some degree to the metallic fumes the pouring is probably the source of greatest danger. As the metal is being poured the atmosphere becomes laden with intensely irritating whitish fumes and fine flaky deposits of zinc oxide or "zinc snow," as it is called. Sir Thomas Oliver gives the following analysis of this "zinc snow":

Moisture	9.64
Organic matter	39.42
Silicious residue	9.14
Oxide of zinc	28.82
Oxide of iron	2.78
Copper	1.71
Other matter	8.49
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	100.00

Another analysis gives 44.9 per cent. zinc.

It is this volatilized zinc or "spelter" impregnating the atmosphere breathed by the workmen that we think is the cause of the "spelter chills." As to their ultimate cause we are not prepared to speak. Lehman believes the symptoms are due to an auto-intoxication from absorption of dead epithelial cells lining the respiratory tract, the cells being destroyed by the inhalation of zinc oxide fumes. Rambouse says that neither pure copper nor pure zinc gives rise to poisoning, yet the pouring of brass, an alloy of zinc and copper, sets up a peculiar train of symptoms. The question of infection seems doubtful. It is probably an acute intoxication.

Thackrah in England, in 1830, recognized a definite train of symptoms arising from the inhalation of volatilized zinc, but makes no reference to the chills. Greenhow in England, in 1845, described a condition "similar to an intermittent fever of an irregular type." Blandet and Greenhow were also aware of a form of poisoning observed in brass pourers. The chills themselves seem to have been first observed by Schwitzer, in Germany, in 1862. The observations of Siegel made in Wurttemberg in 1905 are, however, the most valuable on the subject. Rarely has the condition claimed the attention of American writers, a few reports of individual cases only having been made in Chicago, in 1904, by Drs. Ungre and Savin and by Dr. S. R. Pietrowieez. Dr. Kober comments on it in his report to the House Commission. Dr. Hayhurst in his "Report on the Investigation of the Brass Manufacturing Industry in Chicago" contributes the most elaborate American report.

CONDITIONS PREDISPOSING TO CHILLS.—Respiratory and circulatory disturbances favor a more sudden and severe onset of the chills. Minors and women and those unaccustomed to the work are more susceptible than others. Alcoholism, anemia, malnutrition, and impaired renal function likewise constitute predisposing causes.

Characteristic of the chills is their tendency to attack the workmen every Monday. This may perhaps be due to the free indulgence in alcohol over the week end. The chills occur most frequently in winter, this undoubtedly being due to the greater accumulation of the fumes in the workshop owing to the windows not being open. Their frequency is further increased on damp, cloudy days on account of the heavy atmospheric conditions and consequent difficulty in clearing the room of the fumes.

DESCRIPTION OF THE ATTACK.—The chill may begin while the man is at his work in the latter part of the afternoon and after the second pouring, but more often it begins soon after leaving the shop or in the early evening. (This we think is due to a diminished activity of the sweat glands after leaving the overheated shop.) Free perspiration, by favoring an excretion of zinc, not only aids in aborting the chill but noticeably diminishes the intensity and duration of an attack. For this reason the men resort to hot drinks, the most efficacious, one of our patients told us, being hot milk with red pepper. For the same reason the men wrap themselves in blankets.

The first thing complained of is a creepy, chilly sensation up and down the spine which gradually extends throughout the entire body. It may continue as a mere chilliness, but more often develops into a genuine rigor which lasts for from one-half hour to an hour or even from two to three hours. At its height, cramps and pains in the limbs are apt to occur; abdominal pain is infrequent, except as it may follow the ingestion of cold drinks. The pulse is increased in frequency and there is a slight elevation of temperature. Preceding the chill there is a dry, scratchy sensation in the throat, a sticking, pricking feeling

in the tongue, oppression in the chest, and an irritating cough, usually unproductive. Actual dyspnea is rare. There is a feeling of prostration and of nausea which frequently eventuates in severe vomiting. Diarrhea is common; indeed, the men at all times have a tendency to diarrhea, constipation being rare among brass molders. As the attack subsides the patient, quite exhausted, breaks out into copious perspiration and soon falls into a deep sleep. A temporary loathing for food and an unpleasant metallic taste in the mouth are present on awakening and last a little while.

One of us exposed himself for two afternoons to the fumes and flakes of zinc oxide during the melting and pouring process. In a few minutes the above-mentioned irritative condition in the throat and chest, with coughing, was experienced. Headache also developed, and later a slight diarrhea. No chilliness, however, was felt.

The attacks do not often incapacitate the workers. For this reason, and also because the men accept the "chills" as a matter of course and of no moment, the physician rarely has the opportunity of witnessing an attack. Great numbers of these workmen, it is reported, visit the out-patient department of the Birmingham Hospitals, but always for respiratory and digestive disturbances.

It is doubtful if single attacks of this affection are of any importance, but repeated again and again, as they usually are, sometimes for many years, they undoubtedly produce far-reaching effects in the human economy.

Among the chronic manifestations of the intoxication, those pertaining to the pulmonary system are the most serious. Brass-founders are especially subject to bronchitis and phthisis, and frequently succumb to pneumonia. A very high death-rate from lung diseases is recorded among the Berlin foundries.

A tendency to arthritic attacks with acute and chronic joint manifestations we feel has been somewhat overlooked. One of our patients at present is convalescing from a severe attack of acute inflammatory arthritis complicated with an acute endocarditis and pneumonia. Another suffers with chronic arthritis deformans, and still others have repeatedly complained of mild though definite joint symptoms. Gastro-intestinal disturbances are common; among the more ordinary are attacks of anorexia, headache, apathy, epigastric distress after eating, nausea, and diarrhea. Jaundice sometimes occurs. We have knowledge of an especially interesting case of jaundice which we feel was directly due to zinc intoxication. Unfortunately, we were not able to study it. Among his coworkers the man was known as "yellow-brass Rudy." He was especially subject to the chills, and became markedly jaundiced within a few hours after pouring yellow brass. He could pour red brass without much disturbance, but would not accept, if he could help it, a position where he had to handle yellow brass.

Among the other ill-effects of this vocation we noted a state of malnutrition, a pasty, sallow complexion, and a slight secondary anemia. (The blood cells showed no "stippling.") A well-developed pyorrhea alveolaris was present in all the cases. We detected no changes in the central nervous system, though tabetic symptoms are said to occur. Chronic renal disease should be looked for. Kohr found that zinc workers may excrete zinc for months in the urine, though often without signs of poisoning, and Weyl mentions a case showing albumin and a trace of zinc in the urine after a chill. No albumin could be demonstrated during the time the patient was free of the chills. Siegel found a trace of zinc, but makes no mention of albumin in the urine after a chill. Goodman demonstrated the presence of copper, but not of zinc, in the urine and sweat of a brass-worker. The man was probably a finisher and not a molder. As mentioned before, brass-finishers and polishers frequently show visible evidence of copper excretion in the sweat (i. e., greenish tint to skin and hair, staining of underwear, and aggravated itching of the skin). These symptoms are all due in a large measure to uncleanness, and frequent bathing and the free use of talcum powder tend to prevent their occurrence. The men are not particularly unhealthy.

As the result of examinations kindly made for us by Drs. John Marshall and Wertheim, we are able to report that analyses of the urine from a number of cases revealed no zinc or copper.

It seems that no great tolerance for zinc is ever required. Men who have been in the trade for twenty-five years and more frequently suffer from the chills. Certain individuals are more susceptible than others, developing a well-marked chill almost every night and a particularly severe one on Monday nights. None of the subjects experienced the chills when not engaged in their work. About 75 per cent. of the men exposed develop the chills. The general mortality rate among these workers is higher than that among other workmen. One authority says it is two and a half times that of farmers. Sir Thomas Oliver notes that "only ten brass-workers were found living out of 1200 casters in Birmingham who were past sixty years of age, and that a superannuation insurance for brass-finishers to begin at fifty-five years of age had only three applicants in a period of some ten years." Hayhurst noted that from among 1761 foundry men the oldest at the trade was seventy-three years of age, that only 17 were past fifty, that 60 were past forty-five, and 180 past forty years of age.

GENERAL CONCLUSIONS.—Spelter chills lie in the field of preventive medicine. To eliminate them the following precautions should be observed on the part of the employer:

Guard against inhalation and ingestion of metallic vapors by providing the working rooms with an efficient system of ventilation practical for all seasons of the year.

Keep the furnace room apart from the others and provide proper ventilation about the furnaces.

Employ an improved technique for pouring when such is at fault—perhaps some automatic device.

Provide for the removal of all metallic dust and deposits about the foundry by a systematic and thorough cleansing, at regular intervals, of the floor, walls, ceiling, rafters, etc.

—Employ strong, healthy men to do the work demanded in brass foundries, zinc smelters, and in any allied trades in which zinc is poured.

Do not employ minors or women.

Do not demand of the workmen an amount of labor that is fatiguing.

Provide proper washing and toilet facilities, and advise the men as to the necessity of their proper use.

Allow the men reasonable time for washing before their eating period and a suitable place for eating.

Caution them to change their clothes before leaving the shop. Advise them not to wear mustaches and to employ respirators when necessary. Caution them against sudden changes in temperature.

A study of industrial diseases is of great importance and should form part of the curriculum of medical schools. With the help of the State, which is now assured in Pennsylvania and in several other commonwealths, it will be possible to inaugurate methods of prevention that will greatly lessen disease and increase the efficiency of the workers.

UNILATERAL RENAL HYPOPLASIA AND DYSPLASIA DUE TO DEFECTIVE ARTERIOGENESIS; RELATION TO SO- CALLED HYPOGENETIC NEPHRITIS.¹

By W. M. L. COPLIN, M.D.,

PROFESSOR OF PATHOLOGY, JEFFERSON MEDICAL COLLEGE, PHILADELPHIA.

THE facts embraced in this communication are presented in support of a contention that there is a type of renal anomaly of developmental origin which predisposes to or renders inevitable some form of nephritis, and that this congenital abnormality is probably primarily a defective arteriogenesis necessarily early in the evolution of the organ; furthermore, it is thought that some evidence, based on morphology, is here presented for the first time. The material upon which the report is based represents an accumulation of four years. In order to establish the thesis enunciated it is

¹ Read at the meeting of the Association of American Physicians, May, 1916.